# An Environmental Impact Assessment of Ubuntu 1 Exploration Drilling Project


Report Prepared for

**Eaglewood Energy Inc**

By

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**July 2010**

# Contents Page

# EXECUTIVE SUMMARY

A biological, ecological, physical, and chemical assessment of the Ubuntu Well Pad and the adjoining forest and river system was conducted from 17-22 June 2010. The aim of this study is to provide data on the biodiversity and the physical environment of the proposed drilling area. The elevation of the drilling site is approximately 180 m above sea level. It and drains into the Tuo and Elevala rivers.

The forest of Ubuntu is a typical lowland hill rainforest with four recognizable canopy layers with a more or less uneven smooth main canopy. A total of 201 species of plants were recorded representing 121 genera and 65 families in 0.2 ha of forest. From those results, he species diversity in Ubuntu- can be considered relatively high.

Plant species composition and recruitment patterns in the disturbed areas and slopes showed marked differences. Recruitment on side slopes was noticeably higher than on the Drill Pad; this is directly related to soil compaction. It can be deduced from the species richness data from nearby rainforests and the disturbed sites that the vegetation will recover in all degraded sites after the drilling activities are completed.

A total of 28 species of mammals (including flying mammals) in 8 families were recorded at Ubuntu A. Of the total, 46.4% are endemic, 14.3% are vulnerable, 3.6% endangered and 10.6% rare.

A total of 84 species of bird fauna were recorded. Of that total, 44.0% are endemic, 2.4% are vulnerable, 8.3% are near threatened and 1.2% rare. Four species of recorded birds (Chinese Goshawk, Oriental Hobby, Sulfur Crested Cockatoo and Rainbow Lorikeet) are registered under IUCN category.

Generally, the fauna species present in the forest surrounding the Ubuntu 1 drill site are well distributed within the upper Fly River region.

The fish fauna in the Tou River and its tributaries is similar to other nearby tributaries and stream including the Elevala River. There is no recorded case of fish dying in the river systems in the past; therefore, the company will need to manage the disposal of its drilling fluids and closely monitor its impact on the aquatic flora and fauna.

The soil was uniform throughout the project area and comprised of three distinguishable horizons; O horizon of 3-8 cm in depth containing un-decomposed organic material, an A-horizon consisting of well drained sand-clay with varying depth of 5 - 20 cm, followed by a B-horizon with an extensive reddish clay, ranging from 100 – 200 cm in depth.

Soil erosion is quite high in the area due to high rainfall therefore all materials to be excavated in the future must be pushed to more stable areas to prevent eroded materials from flowing direct into the Tou River.

On the Rig site, the base and walls of the turkey's nest needs to be properly prepared to prevent leakage and also improve the outflow drain.

There rig boards abandoned on site must be removed or pushed to the edge of the well pad and covered with soil material to prevent being thrown as missiles from strong air drafts from Chinook helicopters flying over.

The surface water runoff from the well pad flows along a drain towards the southeastern side of the well pad and drains into a normally dry creek bed that enters the Tou River above the water source. The drain needs to be diverted back to the northern side to avoid contamination of the water source and sediment overloading in the waterway.

The project site is located in the headwaters of the Tou River and three small streams flows from the site. During the time of this survey, the water in these streams was observed to be clear and free of silt and other debris.

The Hagana (CPS) Camp manages the Rig Site. However, the facilities in the camp must be upgraded to ensure that the company's HSE standards are enforced. Some of the facilities to be upgraded include the accommodation blocks, messing and shower facilities, field toilets and waste management pits.

The small camp below the Rig Site must be managed as part of the Drilling Health, Safety and Environmental Management Plan. The plan should include regular awareness meetings with the residents to ensure adherence to all procedures, especially those relating to management and disposal of waste products.

Solid waste materials, including all domestic wastes from the camps and offices, kitchen refuse, and discarded cables and metals from workshops, must be segregated into combustible and non-combustible rubbish, then disposed of in the appropriate pits. These pits must be backfilled and covered with soil at the completion of the drilling program.

Oil, fuel, grease and other liquids containing hydrocarbon must be stored in bunds with sumps to capture and recover all spillage. Waste hydrocarbons must be disposed of at approved locations.

Drilling fluids must be managed in a settlement pit prior to slow release into the environment at the northern end of the site.

The location selected for extraction of water is considered adequate and capable of supplying the required volume of water for drilling activities and other support facilities. The river discharges about 3164 M3 per hour. A log book must be maintained on site to record and monitor the volume of water extracted each day from the source.

Aspects of the drilling activities that carry medium environmental risks and which must be managed include:

- A reduction in water level at the water source caused by prolonged dry spells;
- Contamination of the water source and waterways from high deposition of soil materials, drill cuttings and leached chemical and hydrocarbon spills;
- Flooding of vegetation, due to accumulation of discharged drilling fluids; and
- General littering of the environment and waterways.

Management strategies to address the impacts of the operations on the environment are proposed; details of these strategies need to be put in place as part of the HSE Management Plan for the project site.

A surface water quality monitoring program is required to provide data to manage any unforeseen impact of the operations on the river systems and to ensure that the operation is in compliance with the permit. Strategic sample points have been selected from which baseline water samples have been collected for analysis. These sample sites are provided in this report.

Baseline data for surface water quality is not covered in this report as they were not available. A separate report will be prepared and submitted as an attachment when the data is available.

# 1 Introduction

Eaglewood Energy Inc (EEI) has proposed to undertake exploration drilling at Ubuntu 1 in the Nomad District, Western Province. The project site is located at 06 07'03.6" S and 141 55'17.5" E (Fig. 1) within PPL 259. The site was cleared and a well pad prepared by Carson Pratt Services (CPS) in 2007. However, further works on the project had been suspended up to now.

A team of Environmental Consultants consisting of two professionals and two undergraduate trainees carried out an environmental impact assessment of the project area from 17-22 June 2010.

The assessment covered the terrestrial flora and fauna, freshwater aquatic flora and fauna, hydrological systems around the well pad, surface water quality and the water source for drilling activities and support facilities.

Ubuntu 1 will be the first site with PPL 259 to be drilled for oil and gas. The company has identified other potential areas within this PPL and drilling is planned also for these sites.

The project site is accessed by helicopter from Mendi and Kiunga, or by boat from Kiunga.

# 2 Objectives

The overall objective of this assessment is to provide a detail environmental impact assessment (EIA) of the drilling activities to be carried out in the project area.

The assessment in the field covered the flora and fauna within the project area. Also evaluated was aquatic flora and fauna, rivers, streams, creeks, plus surface water quality and water flow within the catchment area and well pad. Surface water runoff from the pad was also assessed, and physical properties and characteristics of local soil structure were recorded

**Other objectives were:**

To update data on existing environment and provide the required information to develop a Drilling Environmental Management Plan for the project site.

To review existing published formation (if any) on the biophysical environment of the project area.

# 3 Project Site

The Ubuntu 1 Exploration Drilling project is located close to the headwaters of the Tou River, one of the tributaries of the Elevala River. Access to the project site from Kiunga is by helicopter or 6-10 hrs by boat up the Fly River, then crossing over to the Elevala River. The project site is managed and maintained by CPS via the Hagana (CPS) Camp.

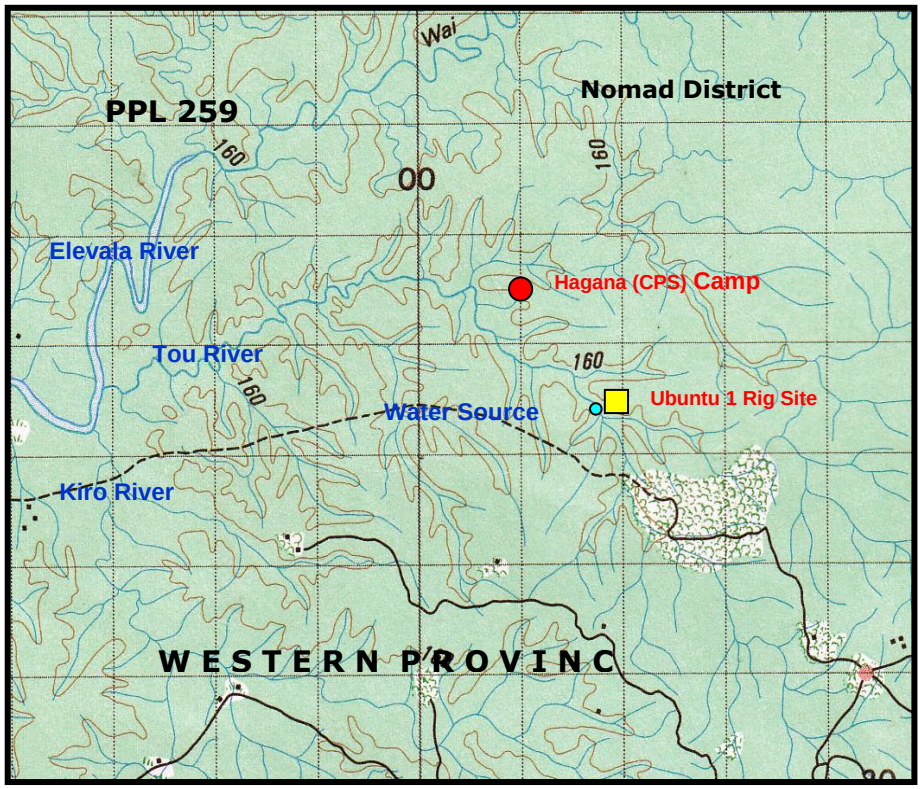


Figure 1. Map showing the locations of Ubuntu 1 Exploration Drilling Rig Site, the Hagana (CPS) Camp, the water source and river systems within the project area.

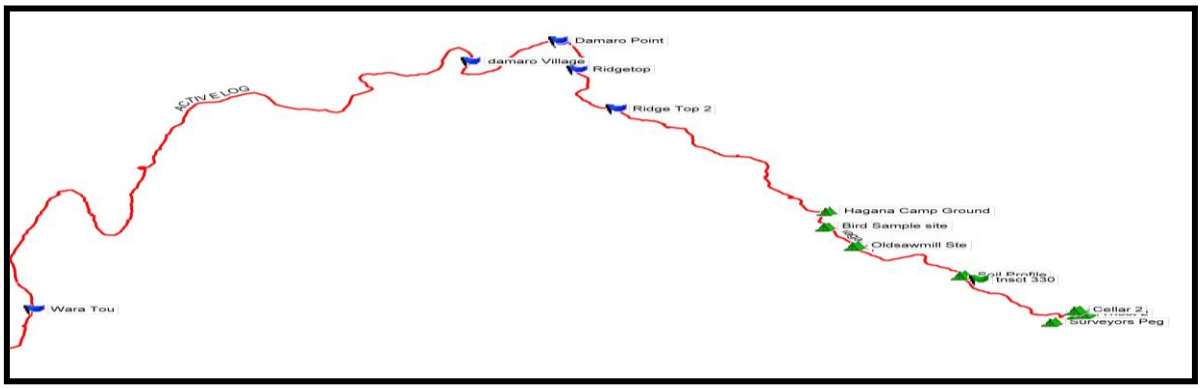


Figure 2. The section of the route from the confluence of the Tou and Elevala Rivers to the Ubuntu 1 Rig Site.

# 4 Travel Itinerary

The team flew from Lae to Kiunga via Port Moresby on 16 June 2010 and traveled to the project site on the following day via 40hp dingy. They were accompanied by the company's Community Affairs officer and three casuals from the project area.

- 16/06/10 – Traveled from Lae to Kiunga via Port Moresby, overnight at Kiunga
- 17/06/10 – Departed Kiunga by dingy for project site, overnight in a bush hut near Damalo village
- 18/06/10 – Traveled from Damalo to project site, carried out reconnaissance survey and field work
- 19/06/10 – Field work at project site
- 20/06/10 – Field work at project site
- 21/06/10 – Departed project site for Kiunga
- 22/06/10 – Departed Kiunga for Lae

# 5 Review of Existing information

A review was carried out on the reports and data available during the preparation of this report. Information drawn from these are discussed in relevant sections in this report. It was noted that additional reports relevant to this project may be available elsewhere in other institutions.

# 6 Characteristics of the Physical Environment

## *6.1 Generalized Geological Structure of the area*

The Ubuntu drilling exploration project area is situated in the Nomad district, Kiunga and occupies the Fly Platform (CSIRO, 1971; Loffler, 1977). The Fly Platform is part of the stable Australian shield, which extends from Cape York below Torres Strait islands and also near Mabaduan on the New Guinea mainland (Loffler, 1977).

The Fly Platform (Fly Digoel Shelf) is a stable shelf area constituting a vast plains and lowland area associated with the Fly and Strickland Rivers. The landforms are composed of heavily weathered limestone in the plateau to the northwest of the lowlands. It is overlain by grandiorite, Permian diorite gabbro, and mostly clastic sedimentary to terrestrial clastic sedimentary rocks (CSIRO, 1971). Geologically, the Fly Platform is relatively stable compare to the adjoining Papuan Fold Belt, which is still active towards the Central Cordillera to the northeast.

## *6.2 Geomorphology*

The Ubuntu drilling exploration site, located at 180m above sea level, is part of a relict alluvial plain of the Fly-Digoel platform. The platform is dissected to varying

degrees by numerous meandering rivers and low undulating depressions, with slopes ranging from 10-30°. The Fly-Digoel platform is part of an extensive volcano-alluvial fan overlain by the predominantly fluvial sediments to the south and west. (Loffler, 1977).

## *6.3 Soils*

Soils around the Nomad area are mostly loam clay to sandy clay loam overlaying red and or prominently mottled clay loam to clay and uniform-textured red clay loam to clay, acid to strongly acid, generally well drained crest and plateau locally imperfectly drained. On the valley floors are mostly alluvial clay loam and clay with organic soils which are poorly drained.

In the Nomad area, the subdominant soils are mostly plintochrults, dystrochrepts, and typochrults (Bleeker, 1983).

## *6.4 Hydrology*

The project area is located in the head waters of the Elevala River, one of tributaries of the Fly River, The Elevala River is about 500 km long, starting from the junction with the Fly River, The major tributaries feeding into the Elevala River includes the Wai Ketu, Buguin, Au, Wai Menge, Tana, Kiro and Tou. In addition, there are numerous creeks and streams flowing directly into the Elevala River.

The Rig Site is situated within the head waters of the Tou River, the runoff from the catchments of the surrounding hills and ridges flows into the Tou and enters the Elevala River.

There are two creeks which flow directly from the Rig Site into the Tou River; they do not have the capacity to transport large volume of materials as they are active only in the wet season. The Tou River discharges an estimated 150 $m^3$ of water per second and more during the high rainfall periods.

## *6.5 Climate*

The climatic condition of the project area is similar to regions to the west and north of the upper Fly River. The area is located within the lower mountains to the south of the central caldera where precipitation higher than that of the middle and lower areas of the Fly River.

Local climatic conditions are controlled by two wind movements: the relatively drier northwest season (June to September) and the wetter southeast trade winds December to March). The transition from one system to another occurs during April-May and October-November.

Locally, these air masses are greatly influenced by factors connected with weather patterns of northern Australia, including cyclonic disturbances (McAlpine, et al. 1981). They also are affected by local air circulation induced by topography and the heat differential between land and sea.

The Kiunga area experiences high humidity, with annual precipitation ranging from 1500-2063mm, and a mean temperature of 26.9°C.

## 6.6 Vegetation

The vegetation of the Upper Fly and Strickland areas is influenced by the three primary environments which are determined by local climatic and soil conditions. These environments are (1) relict alluvial plains, which cover much of the areas between Kiunga and Strickland Rivers, (2) alluvial flood plains, and (3) swamps (Paijmans, 1976; Hammermaster and Saunders, 1995; McAlpine and Quigley, 1998). The latter two environments occur along the Fly and Strickland Rivers and their tributaries,

Two distinctive forest types observed along the Elevala River are low altitude forest on the plains and fans, and an upland low altitude forest. The first forest type is mostly found along rivers and swamp and only represents a small area as compared to the upland low altitude forest.

# 7 Methodology

## 7.1 Assessment of the Physical Environment

A quantitative assessment was carried out using the topographic map and rainfall data for Kiunga. A three year long-term average rainfall of 4000mm, was considered representative of the project site. Peak flow was estimated using the flood formulae by (Dickens) and double-checked using the peak flow equation for catchment areas less than 76,000km$^2$ (SMEC, 1990). Flow measurement was conducted at a selected point along the Tou River below the Rig Site.

## 7.2 Soil Description

Qualitative descriptions of the local soil was carried out using 2.0m soil profiles from roadside cuts, and following the USA-FAO soil classification system (Bleeker, 1983). The thickness of different soil horizons was measured using changes in colour through soil depth. Soil texture and structure evaluation was done using the field grading mechanical analysis method.

## *7.3 Total Species Richness Count*

Basic forest community parameters were assessed for one sample plot, using standard vegetation analysis such as those presented in Mueller-Dombois & Ellenberge (1974).

A temporary 0.2 hectare (ha.) sample plot of belt-transect (6 m x 333 m) was established along a central reference baseline. Thirty two subplots were set out within the belt-transect along the baseline. Each subplot was 6 m wide (3 m each side of the baseline) by 10 m long, except for the last sub-plot (33), which was extended an extra 3 m along the baseline to 13 m, to give a total sample area of 2000 $m^2$ (0.2 ha). Each subplot further divided into four 3 m x 5 m quadrats to enable easier location of individual plants, giving a total of 66 quadrats (64 of 3 m x 5 m and two of 3 m x 8 m) (see Figure 2). Sampling of each sub-plot was carried out progressively along the belt transect using the baseline as a central axis. Within each sub-plot, all trees of at least 10 cm dbh (diameter at breast height) and higher were measured with a diameter tape and recorded. The structural formation of all trees > 10 cm dbh was mapped on a 100m forest profile using the baseline as a reference.

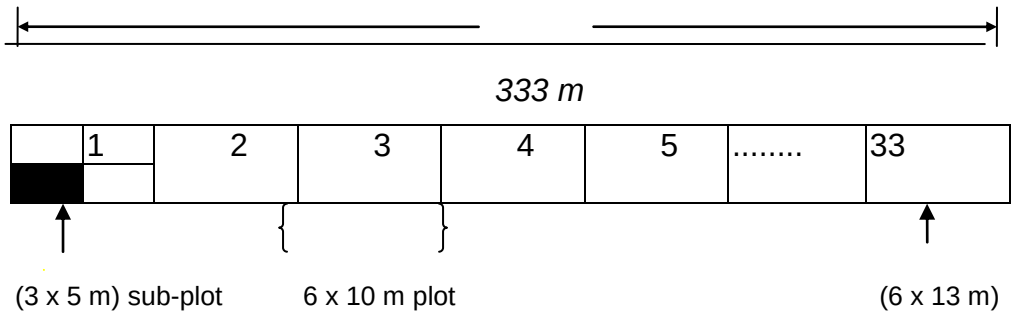


Figure 3. Sketch of the belt transect plot (6 m x 333 m) from which all vascular plant species were enumerated.

All individual plants, including epiphytes occurring up to 10m above ground level were progressively counted within the transect to determine total species richness and to ascertain any spatial patterns.

## *7.4 Processing of Herbarium Voucher Specimens*

Most sampled plant species were photographed in the field using a digital camera (Nikon Coolpix 5700, 8 megapixels). Voucher specimens were collected and pressed in air-tight plastic bags containing 70% ethanol for transport to the Papua New Guinea Forest Research Institute (PNGFRI). At PNGFRI each specimen was removed from bags and press-dried in an oven at 80$^o$ C., after which they were taken to the Lae National Herbarium for identification. All specimens were identified to at least genus; specimens containing flowers and/or fruits were identified to species.

## *7.5 Stand Structure and Size Class distribution*

Stand structure for the forest was calculated using a descriptive analysis method contained in the Microsoft Excel 7.0 statistical analysis program. The basal area ($m^2.ha^{-1}$) was calculated using the equation 1 **[BA = $f$(μDBH$^2$ x π)/10,000]**, where $f$ is frequency, **μDBH$^2$** is the square of the mean diameter of the stand, and π is 3.142.

## *7.6 Mammal Diversity Survey*

Non-flying mammals were sampled by systematic trapping and spoor surveys along trails, and by interviewing local landowners about mammals that are usually seen or hunted in the Ubuntu area.

### *7.6.1 Trapping*

Small mammal trapping was done by establishing trapping transects along which small Elliot traps were laid. The traps were laid randomly on the ground or on fallen logs on the forest floor. The traps were baited every morning with coconut and/or oats with peanut butter to lure mammals/rats. The day's catches were brought to the camp for identification, photographed, identified, then released back at the original capture site. Trapping was carried out for 3 days. Reference text books, including Menzies and Dennis (1979) and Flannery (1995) were used to make identifications. Each day during daytime, tracks were walked and any spoor and droppings encountered were recorded and identified. Local informants were consulted for species identification confirmations as needed.

### *7.6.2 Local Information*

Three local informants from Damalo village were interviewed to learn about any recent encounters of vertebrate species suspected to be present in the study area. They were shown pictures of mammals from Flannery (1995), and detailed conversations about behaviour, habits etc were conducted. Only records believed to be reliable were included in the analysis.

### *7.6.3 Opportunistic Search*

Opportunistic search for larger mammals were carried out in the field to increase sampling effort and to accommodate the variation in the behaviour of larger mammals.

Daytime searches involved recording:

1. Foot prints in the soil
2. Disturbances on the soil surface
3. Holes dug
4. Tooth marks in fallen remnants of food

5. Faecal counts
6. Nesting and foraging sites.

Nocturnal (night time) search involved;

1. Recorded call play backs of mammals
2. Bats activities

## *7.7 Avifauna (Birds) Survey*

During the bird survey of the Ubuntu proposed drill site, three methodologies were used to collect data during the limited time available; *1) mist netting, 2) local informant's knowledge,* and *3) opportunistic search*.

### *7.7.1 Mist Netting*

Three 6 meter mist nets were set across the same transect where the mammal traps were laid for 2 days. The nets were opened every early morning and watched at a distance for more than 30 minutes. Any catches in the nets were identified in the field and the birds. The process continued all day. At dusk the nets were lowered and closed for the night.

### *7.7.2 Local Informants' knowledge*

Locals were consulted by showing them pictures in the field guidebook "Birds of New Guinea" (Beehler, Pratt & Zimmerman, 1986). Bird species reported by locals of their occurrence in the area were recorded, using pictures from this field guide for reference. The interviews were carried out in the evenings when everyone was at the campsite to ensure verification of the information being gathered.

### *7.7.3 Opportunistic search*

Each day opportunistic searches were conducted to identify and record birds that dwell high in the canopy, and any others not recorded from mist net catches. This was done with the aid of binoculars, while consulting the bird field guide. Some of bird species were recorded using their calls. Cassowaries were recorded from evidence of droppings on the forest floor.

## *7.8 Herpetofauna (Frogs and Reptiles)*

### *7.8.1 Opportunistic search*

Frog diversity was assessed at night by locating calling males and through visual encounters. Equal efforts were made along streams and in the vicinity of the proposed well pad and camp sites. The nightly assessment was conducted between 06:00 pm and 11:00 pm. Some frogs were identified in the field with the aid of *Frogs of New Guinea* by Menzies (1976) and *Frogs of Kikori River Basin* by

Richards (2002). Snake and lizard diversity was assessed from random searches on the forest floor during daylight hours. Voucher specimens were photographed.

### *7.8.2 Local Informants' knowledge*

Local informants were interviewed at leisure time of their recent encounters of snakes suspected to be present in the study area. They were shown pictures of in the *Snakes of Papua New Guinea* guidebook by O'Shea (1996), with detailed conversations about behaviour, habits etc. Only records we believe are reliable are included here.

### *7.8.3 Aquatic Flora and Fauna*

Freshwater fishes were sampled using a fish net laid across the Elevala and Tou rivers for 5-8 hours per day. These watercourses were also surveyed for aquatic plants.

### *7.8.4 Surface Water Sampling*

Eleven sample sites were identified along the rivers and streams within the project area. Samples were made from these sites along the Tou and Elevala Rivers. Eight sites were sampled just below the Rig Sites, one at Damalo above stream, one before the junction of Tou and Elevala and another about 20 meters on the Elevala River just after the junction.

Water samples were collected using sterilized 1 liter bottles, stored in the refrigerator overnight, packed with frozen ice packs, and delivered to the laboratory for analysis. The systems sampled included two creeks; Meme & an unknown (Creek 1), as well as the Tou and Elevala rivers.

# 8 Results of Field Assessments

## *8.1 Terrestrial Flora*

The flora of the Ubuntu exploration drilling site is described in the context of plant species diversity, life forms, and the structural composition of closed (undisturbed) forest and disturbed (land cuts and land fills) sites.

The vegetation is typical lowland rainforest (Paijmans, 1976) with distinguishable canopy layers. Four canopy layers were recognizable, including the emergent (45-55m height) and main canopy (30-45m). The forest floor vegetation was uniform and sparse. The prominent physiognomic features included tree bark with smooth fine cracks/pustules texture, and predominantly mesophyllous leaves.

## 8.2 Plant Species Diversity

The vascular plant taxa diversity of the Ubuntu undisturbed natural forest was 201 species, representing 121 genera and 65 families. Figure 4 shows the accumulative numbers of species in a 0.2 ha Ubuntu transect for Ubuntu, with the asymptote curve leveling off after 0.2 ha. Thus, the sample area size was adequate for a general evaluation of plant diversity. The species area curve indicates that a larger sample area would yield more than the 201 species recorded in this survey.

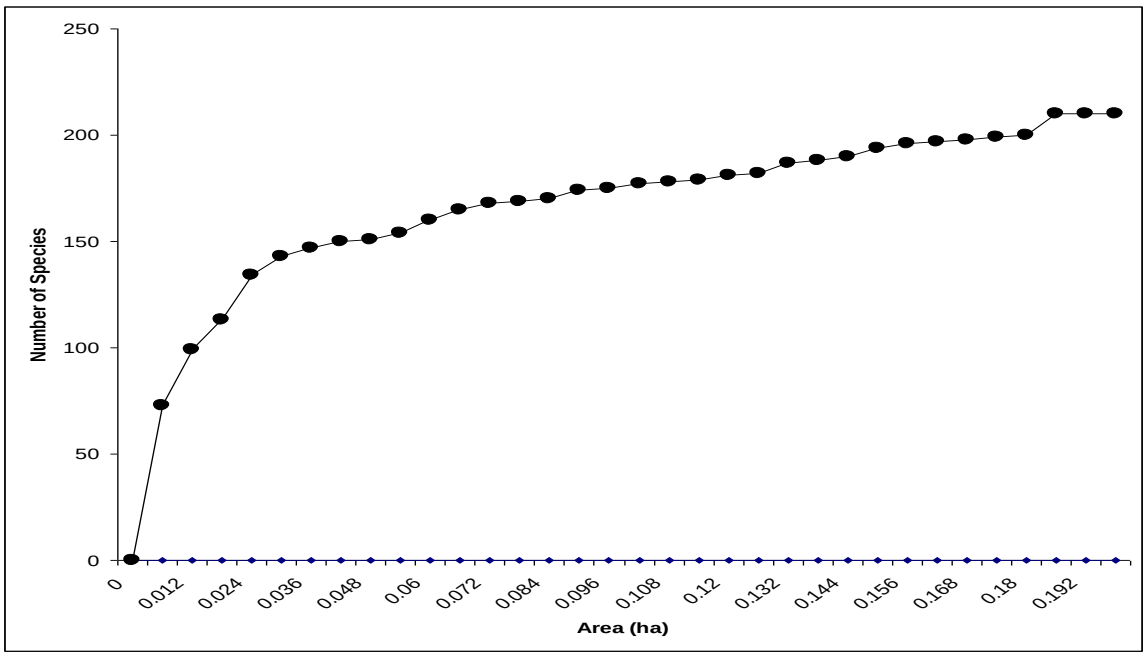


Figure 4. Cumulative number of species in a 0.2 ha (333 m X 6 m). The cumulative species area curve showed an asymptote pattern, leveling off above 0.1 ha. The cumulative species area curve indicates that the sampling size selected was adequate for evaluating species diversity.

### 8.2.1 Disturbed Forest

Species composition and recruitment patterns in the disturbed cut hilltop and push-over soils at the side slopes showed marked differences. The rate of recruitment on side slopes was noticeably higher than for the drill pad site.

Species diversity in the disturbed hill slope push-over soils was markedly (33%) higher than at the drill pad. Thus indicates a vigorous rate of species recruitment on hillside slopes compared to the denuded drill pad site. The hillside slopes had significant amounts of push-over top soil. Generally, soil seed bank composition in the top soil layer is reported to contain significant plant propagules (Saulei and Swaine 1988, Balun, 1993). The rapid rate of recruitment in the side slopes of the Ubuntu Drill Pad area is therefore is likely derived from the push-over top soil and its inherent high soil seed bank.

Species composition and vegetation life forms on disturbed sites showed positive progress in colonization. The 27 species observed within the 30m radius of the disturbed drill pad showed a dominance of trees (33%, Fig. 4.1), which should increase the prospects for wood species colonization and regeneration. The most aggressive invasive life form tends to be lianas; the low abundance of lianas (4%) here predicts a low probability of invasive species dominating the succession process.

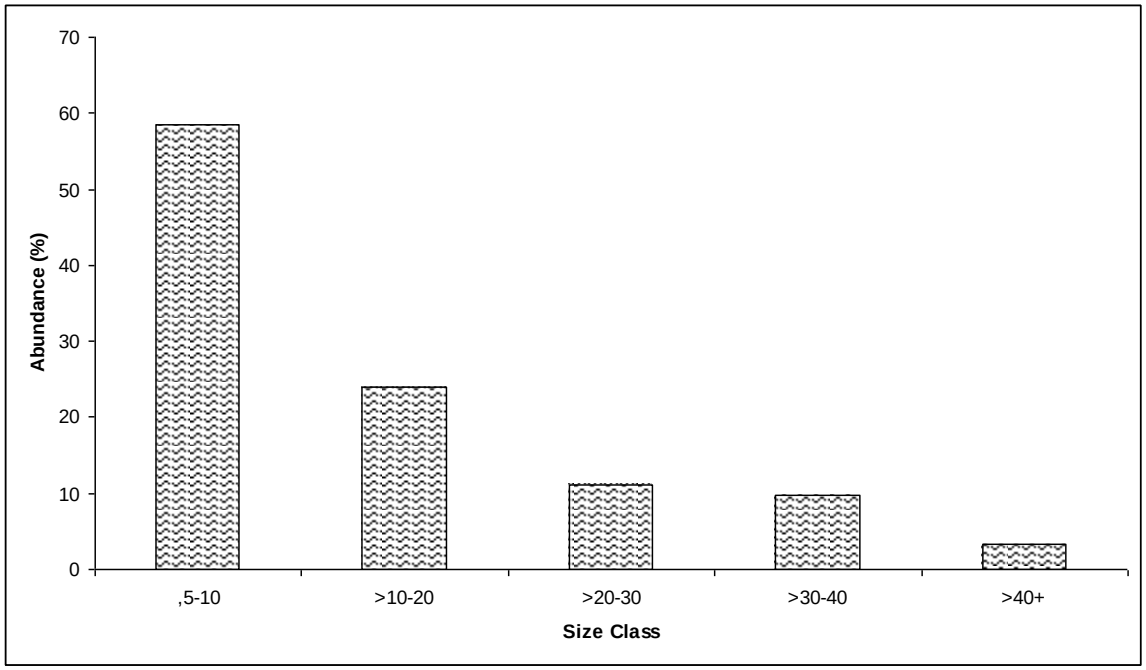


Figure 5. Relative abundance of stem diameter size classes of trees in the Ubuntu forest. Size class composition was comprised of seedlings, herbs, shrubs, saplings (60%) and trees (40%).

### 8.2.2 Well Pad disturbed site

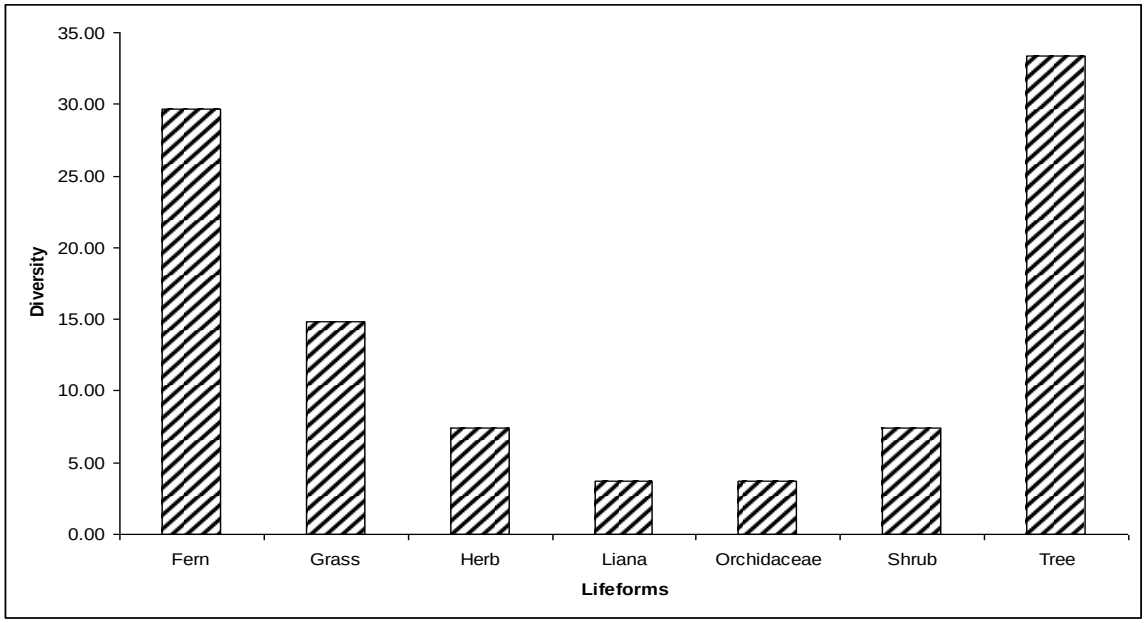


Figure 6 shows the relative percentage composition of different plant life forms in the vegetation succession community on disturbed sites after four years. About 27 species were observed within the 30m radius of the disturbed drill pad area. The most dominant plant life forms at Year Four are; Trees (33%), Ferns (30%), Grasses (15%), Shrubs (7%), Herbs (7%) and Lianas (4%).

### 8.2.3 Regeneration on Well Pad side slope soils

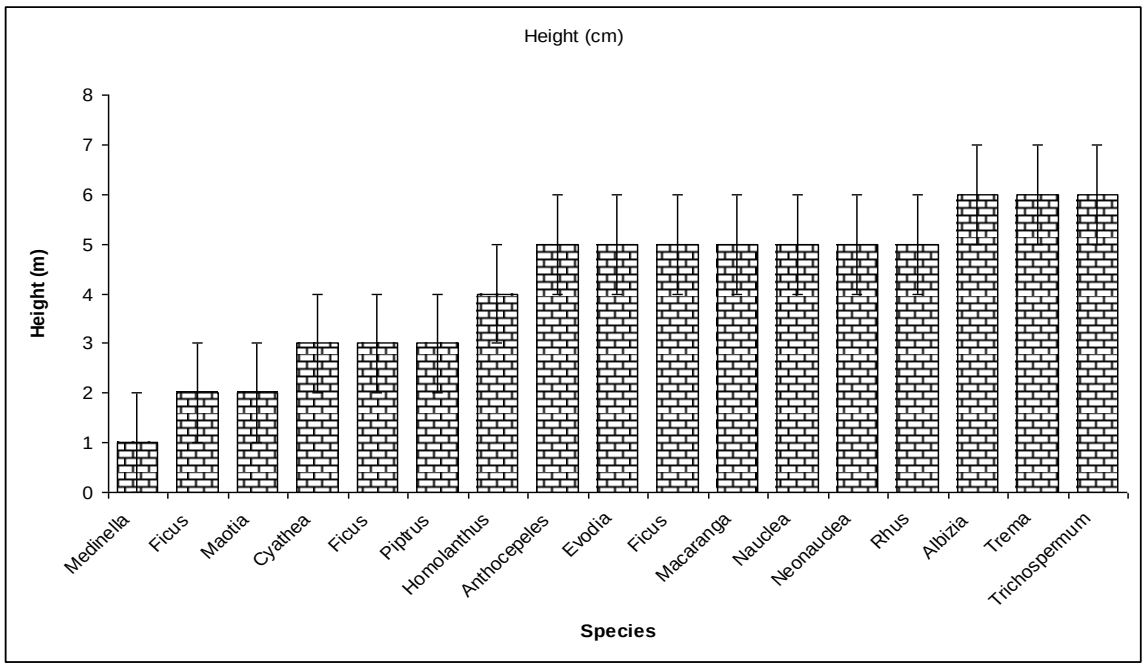


Figure 7. Plant species enumerated from the push-over soils on the sides of the drill pad.

The vegetational succession on the push-over soils at the sides of the drill pad showed vigorous growth in most pioneer tree species. The rate of species recruitment was 33% higher than in the drill pad area. Maximum tree height growth was about 6m, with most species displaying similar canopy height growth (5-6m).

The vigorous regeneration pattern of the disturbed side slope vegetation is attributed to the rich soil seed bank in the top soil. This makes it important that the top soil is stored in easily accessible areas on drill pad site, where it can later be taken and moved back to cover disturbed areas and promote regeneration of local species.

The positive correlation (r=0.482) between the drill pad and side slope sites suggests that seed propagules from adjoining forest are being distributed efficiently between the two sites. Although the two sites may differ in the rate of recruitment, dispersal strategies for the recruited species are similar. .

### *8.2.4 Correlation between species regeneration in two Sites.*

A positive correlation coefficient (r=0.482) which is indicative of a positive correlation between the two sites (Drill Pad and Drill Pad hill side slopes).

## *8.3 Fauna*

All major vertebrate groups were present in the forest surrounding the Ubuntu 1 drill site. The following were assessed in this study; Mammals, Birds, Reptiles, and Frogs. Table 1 shows the number of species recorded from each taxon in the Ubuntu 1 forest.

**Table 1. Number of species recorded for each taxon in Ubuntu A forest.**

| Taxa | No. of species | No. of Families |
|---|---|---|
| | | |
| Mammals | 28 | 8 |
| Birds | 84 | 24 |
| Frogs | 7 | 3 |
| Lizards | 2 | 2 |

The fauna survey revealed a diverse assemblage of fauna comparable to that of Juha region reported in the Oil Search Limited (OSL) Biodiversity Survey Report (2006). The fauna comprised 300 species of birds, 78 mammals (1 echidna, 7 bats, 10 rodents, and 2 marsupials). Also,, 30 frogs, 15 reptiles, and 23 beetles were noted. Of the 108 species of birds observed, 21 species are protected. Of the 21 protected species, 1 is Paradise and Bowerbirds, Vulturine Parrot. These species are classified under IUCN definition as vulnerable and threatened due to

their feeding habits. Other animal taxa, including 1 echidna, 1 fruit bat, 2 marsupials are protected species. The echnidna, (*Zaglossus bruijni)* is classified as vulnerable and threatened, while the bat (Aproteles bulmerae) is classified as near extinction.

## *8.4 Mammals*

Discussions with local experts revealed that the listings for mammals by Singadan (2006) for Juha – B (Main) is similar for Juha - 'A'. The biological and ecological explanatory notes outlined in Singadan and Hiaso (2006) is similar to the finding of this study. Thus, data from Singadan (2006) was reviewed and imported in this report.

### *8.4.1 Marsupials*

Distribution notes, published information and museum collections at the University of Papua New Guinea and PNG National Museum indicate that several species of marsupials that are listed in Appendix 2 can be found at Ubuntu Well Pad. Some species have a localized distribution, while others have a wider range. Those that have a localized distribution are quite vulnerable to forest disturbances and require more attention..

### *8.4.2 Rodents*

In New Guinea there are native species of rats that spend some time of their lives in water. These water rats forage for food on both land and in the river streams. The list in Appendix 2 indicates species that may be present in Ubuntu area, including one or two species of water rats.

### *8.4.3 Bats*

Bats are mobile and are distributed widely except for some small insectivorous or nectar feeders. The most important species in the family are fruit bats. They are responsible for dispersal of fruits, nuts and seeds. Amongst the animals, bats and birds are important in regeneration of plants and the structure of forests because they are highly mobile and can travel longer distances than marsupials, rodents and reptiles.

## *8.5 Frogs (Herpetofauna)*

Seven species of frogs from three families were recorded in the Ubuntu 1 forest area. The presence of this species likely reflects the extremely wet habitats typical of lower montane forest. The number of species encountered is indicative of an environment without environmental contaminants. The species and ecological descriptions are provided in Figure 9.

**Family: Hylidae**
***Litoria* sp. nov.5**.

SVL 30 mm. Slender predominantly green frog with pale brown, heavily reticulated eye. Bright, rust-red on hidden surface of thighs and lower belly. An undescribed species was only known to Iagifu Ridge and Gobe Ridge (Richards, 2002). This sighting and collection now extends the species distribution range into Western Province

**Family: Microhylidae**
***Callulops* sp. nov.**

SVL 57 mm. Dark black/brown coloured frog. Ventral surface grey brown translucent. Eye colour is yellow. Eye spot above groin, lower back. Call a low pitched 1-3 croaks every 10-15 minutes. Skin smooth, no tubercles as in other Callulops species

**Family: Ranidae**
***Rana cf. daemeli***

SVL 77 mm. Grey or brown with bars on legs. Snout angular, legs very long. Inhabits undisturbed forest floor, reproduces in pools on tree trunks and protects eggs from dehydration with its salivary glands

Figure 9. Frog species observed in the rainforests between the Hagana CPS Camp and the Ubuntu 1 Rig Site

## *8.6 Birds*

Some birds were sampled during our survey but more species were observed and later confirmed with the locals (Appendix 2. The birds recorded are kinds that can forage over large forest areas and therefore will not be impacted on by activities associated with the drilling project. Some small forest birds are shy understory species that occupy elevations between 400–2,500 m. The Ubuntu 1 forest has a rich bird fauna due to the availability of food sources and limited forest disturbance.

Figure 10. Some of the birds captured and recorded in the forests between Hagana and the Rig Site.

## *8.7 Freshwater Fishes*

The Tou River and its tributaries contain a limited number of fish and crustacean species. Some of these were caught during this survey. Similar fish species were also sampled in the Elevala River.


Figure 12. Fresh water fish caught in the Elevala River below Damalo village (a) and some from the Tuo River below the Well pad (b).

## *8.8 Aquatic Plants*

A survey for aquatic plants was conducted along the Tou River below the water source but none were found. The only aquatic plant species found and collected was from Haga Creek below the Hagana CPS camp and from another small creek between the camp and the sawmill.

Figure 11. The only aquatic species found in the Haga creek next to the Camp site and also in an unnamed creek along the track to the Rig Site.

## *8.9 Soil Formation and Properties*

The soil was observed to be uniform throughout the project area including the Rig Site. The profile indicated features of a well developed soil with a distinguishable O horizon of 3-8 cm in depth containing un-decomposed to partially decomposed organic matter. The A-horizon layer consisted of well drained sandy-clay with varying depth from 5 - 20 cm. Below this zone is an extensive reddish clay (B-horizon) also varying in depth from 100 - 200cm (Figure 13).

## *8.10 Soil erosion*

Observations made on soil material pushed over the side of the well pad noted that the soils are yet to stabilize. The deposits are eroding away through surface runoff from the well pad, and transported into Meme Creek and the Tou River.

Any additional soils disrupted by future well pad construction likely will be eroded into the waterways if they are not protected from surface runoffs.

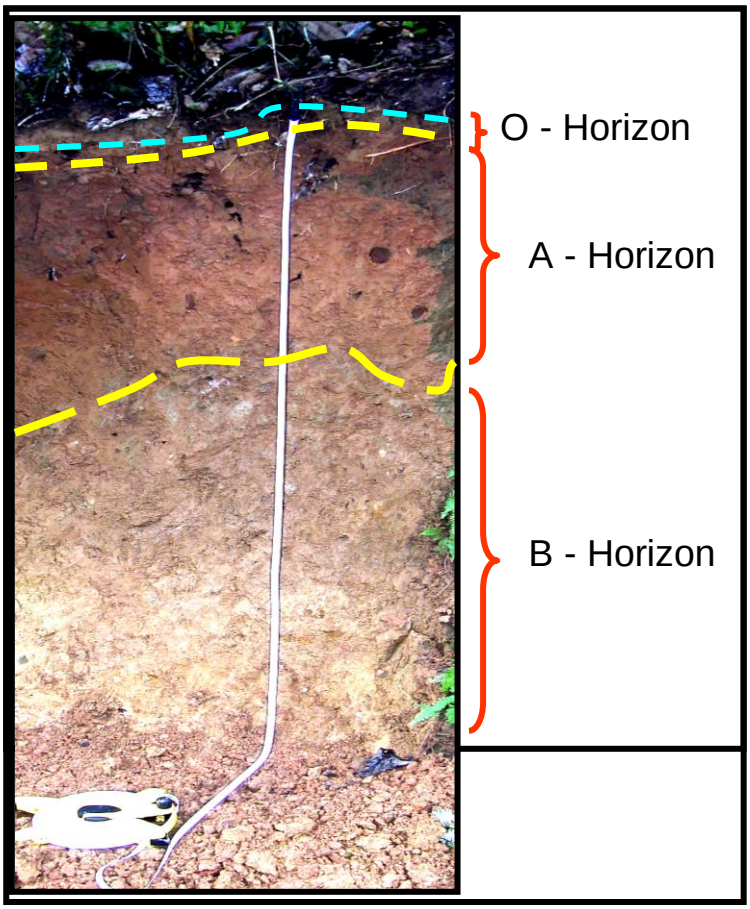


Figure 13. Soil profile taken from an undisturbed site in the vicinity of the project area showing the different horizons.

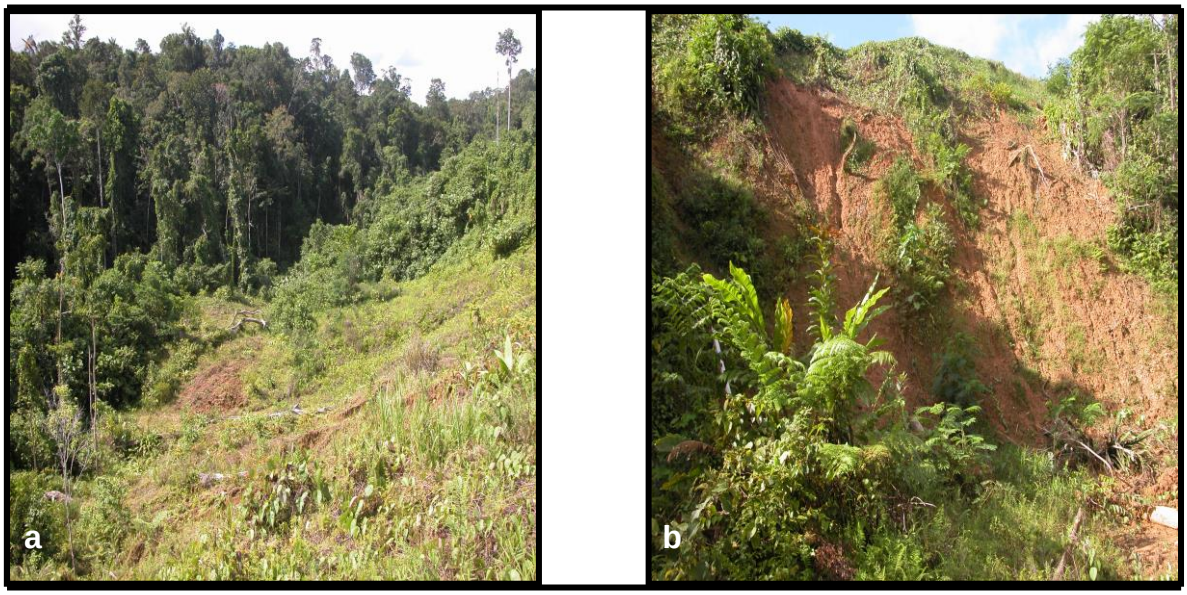


Figure 14. Soil erosion on the northern (a) and southern (b) edges of the Rig Site

## 8.11 Well Pad

The well pad was cleared and constructed in 2007 by CPS. It is comprised of two cellars, a turkey's nest, a rig floor and a site for the camp. Further work on the pad was suspended due to changes taking place in the company. Since then, water has filled up the two cellars, the condition of the pit has deteriorated and the rig boards have been ripped up and displaced from their position. The surface of the pad is also covered with silt materials transported from the higher grounds by surface runoff. There are unstable areas on the edges of the well pad, especially the edges to the north, south and east of the pad.

The surface of the pad will need to be redone to support movement of heavy machinery and other drilling equipments. All waste materials on the pad including the rig boards must be cleared first before upgrading the surface.

The condition of the current rig boards have deteriorated due to exposure to the rain, therefore new ones will need to be sawn from the nearby forests.

The base and walls of the turkey's nest will need to be upgraded and prepared to retain the required amount of water.

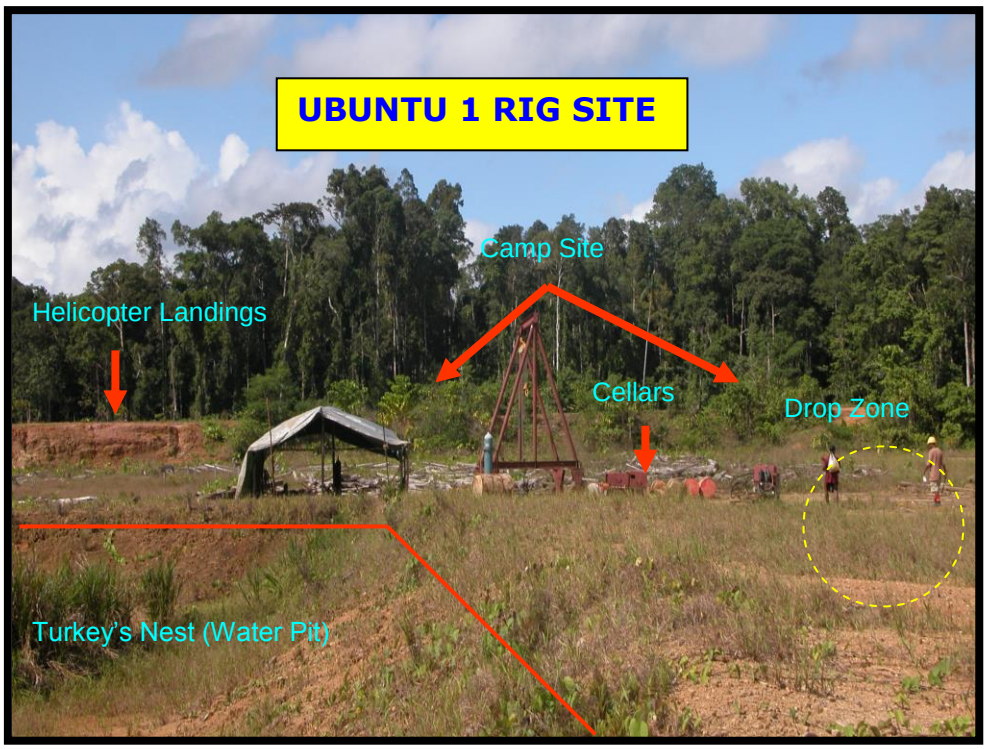


Figure 15. The Ubuntu 1 Rig Site as observed during this survey with the proposed layout of the site. In the foreground are equipments owned by CPS.

## *8.12 Rig Site and Camp Layout*

The layout of the Rig and the camp facilities are shown in Fig. 16 below. This shows the location of drilling rig, the water pit, storage of hazardous chemicals, Halliburton drilling support facilities, the camp site and the helicopter landing pads.

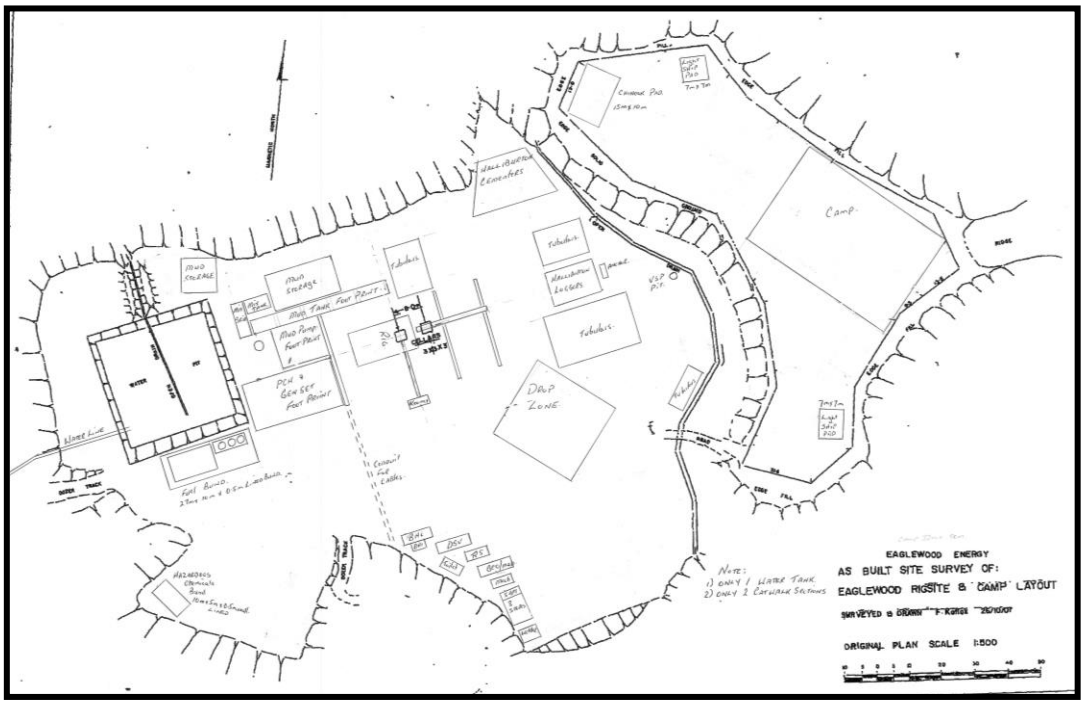


Figure 16. The layout of Eaglewood Energy Rig Site and Camp facilities at Ubuntu 1.

## *8.13 Abandoned Rig Boards on the Well Pad*

It is estimated that a total of 28,000 rig boards were cut and prepared for the well pad in 2007. The rig boards were used on the rig floor. However, after the work was suspended the boards were removed and left behind (Fig. 17 A). These boards will have to be cleared and the surface prepared for the dura mats.

Below the well pad is an abandoned stockpile of rig boards left behind by CPS after the construction of the pad (Fig 17 B). Some of these rig boards could be salvaged and used for other purposes, such as walkways and floors for the camps.


Figure 17. Rig boards removed from the rig pad and abandoned on the Rig Site.

## *8.14 Surface Water Runoff from the Well Pad*

Surface water from the well pad flows primarily from the north towards the southeastern side of the well pad. It drains out into a dry creek and enters the Tou River above the proposed water source. Another usually dry creek originates from the south of the pad and directs into the Tou River after the casual camp.

The surface water runoff needs to be directed away from entering the Tou River as this will increase the sediment load and contaminate the river system with any possible chemical and oil spills on the rig site.

## *8.15 Rivers Streams and Creeks*

The project site is located in the headwaters of the Tou River, which originates from the ridges above the site. The Tou is one of the tributaries of the Elevala River; it flows into the Elevala River and further down, into the Fly River. During this field assessment, it was found that three (3) creeks originate from the well pad; one on the northern side known as Meme creek, one to the Southern side (it was dry during this assessment), with the third being on the eastern side of the well pad. This creek enters the Tou River just above the water source.


Figure 19. Direction of surface water runoff on the Rig Site towards the Tou River and towards the Meme Creek


Figure 20. The Elevala River, the headwaters of Tou River and two smaller creeks within the project area.

## 8.16 Surface Water Quality

During this assessment survey, the waterways were observed to be clear with no noticeable suspended solid in the systems. The materials deposited along the waterway were heavy logs and gravels but there was no sighting of silt materials. From the high water marks on the banks of the Tou River, it was noted that it is capable of discharging large volumes of water (Fig. 21).

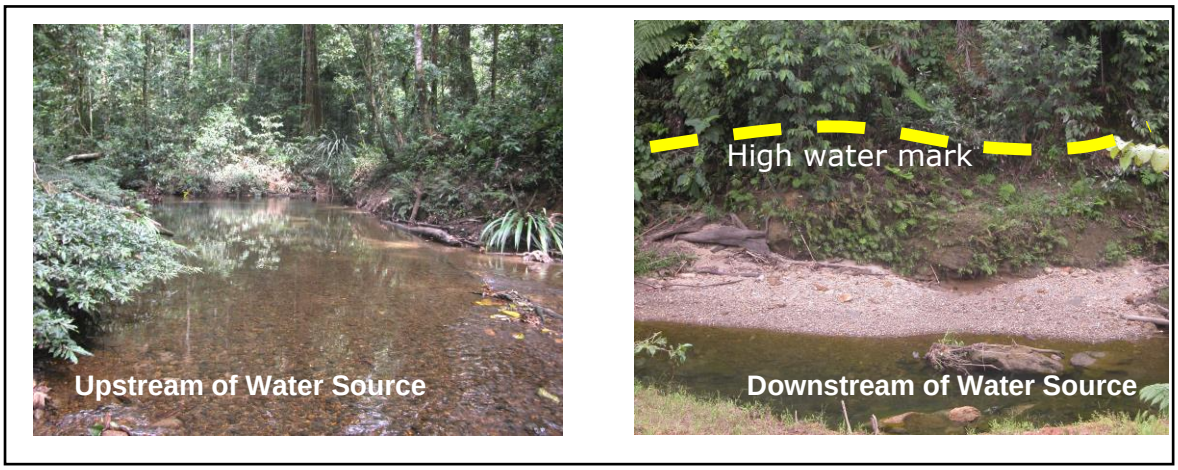


Figure 21. The upstream and downstream of the water source on the Tou River below the Rig Site

## 8.17 Hagana CPS Camp Site

The Hagana Camp is located about 1 km away west of the Rig Site. It is not known at this stage whether this camp will continue to operate or not. However, it has all the basic facilities that are required to support the initial work of clearing and setting up the Rig Site.

The camp will need to be resourced to cater for the increase in people when the work begins. Facilities to be considered for upgrading include accommodation blocks, the messing and shower facilities, field toilets and waste management pits.


Figure 22. The CPS camp at Hagana consist of accommodation units, kitchen, shower and laundry block, generator, water supply and two camps for support staff.

## *8.18 Ubuntu 1 Camp Site*

There is a small camp below the Rig Site that belongs to casual workers taking care of the machines left behind by CPS. These houses are constructed from bush materials, they have pit toilets and take water from the Tou for domestic use.

There is a risk in having the water source close to this camp however the water source area can be excluded from the resident site.


Figure 23. The locals employed by CPS lives here and take care of the CPS machines on the Rig Site.

## *8.19 Solid Waste Management*

Solid waste materials include all domestic wastes from the camps and offices, refuse from the kitchen, and discarded cables and metals from workshops. These waste materials must be segregated into combustible and non combustible prior to disposing into the appropriate pits. These pits will need to be backfilled and covered with soil at the end of the drilling program. The pits must be constructed in a safe location, preferably within the leased area.

## *8.20 Storage of Fuel and Oil Products*

Storage of oil, fuel, grease and other liquids containing hydrocarbon are required to be in bunds with sumps to capture any spillage. All waste hydrocarbons must be disposed off in an acceptable manner that minimizes the risk to the environment. Refer to the standard operating procedures for specifications on the size of the bunds base on volumes to be stored on site.

All metals containing grease must be cleaned prior to disposing in a scrap metal pit on site.

### *8.21 Drilling Fluids and Cuttings*

The waste fluid produced during drilling must be managed in a settlement pit prior to slowly releasing it into the environment. It is noted that the direction the fluid will be released into the environment is on the northern side of the Rig site. This location does not have adequate vegetation cover to filter the suspend materials and a management plan will be needed to outline strategies for dealing with this waste.

The forest area between the well pad and the Meme creek to the west of the pad is already saturated with materials washed down from the Rig Site and therefore may not be able to absorb the discharged fluid.

It is recommended here that the fluid be pumped further into the forest to the northeastern side of the well pad so that there is some distance for filtering to occur before it enters Meme Creek.

## 9 Water Extraction and Water Source

Water for drilling and the camps will be extracted from the Tou River from a location about 300-400 m from the southern end of the well pad. The site has sufficient volume of water to support both drilling activities and to maintain an adequate water level in the water ways to sustain aquatic organisms.

It is estimated that drilling activities will extract 4500 liters per hour from the system. Preliminary calculation of the water flow shows that the waterway discharges about 3,164 M3 per hour.


Figure 24. The water source where water will be extracted to supply drilling and other support activities at the Rig Site.

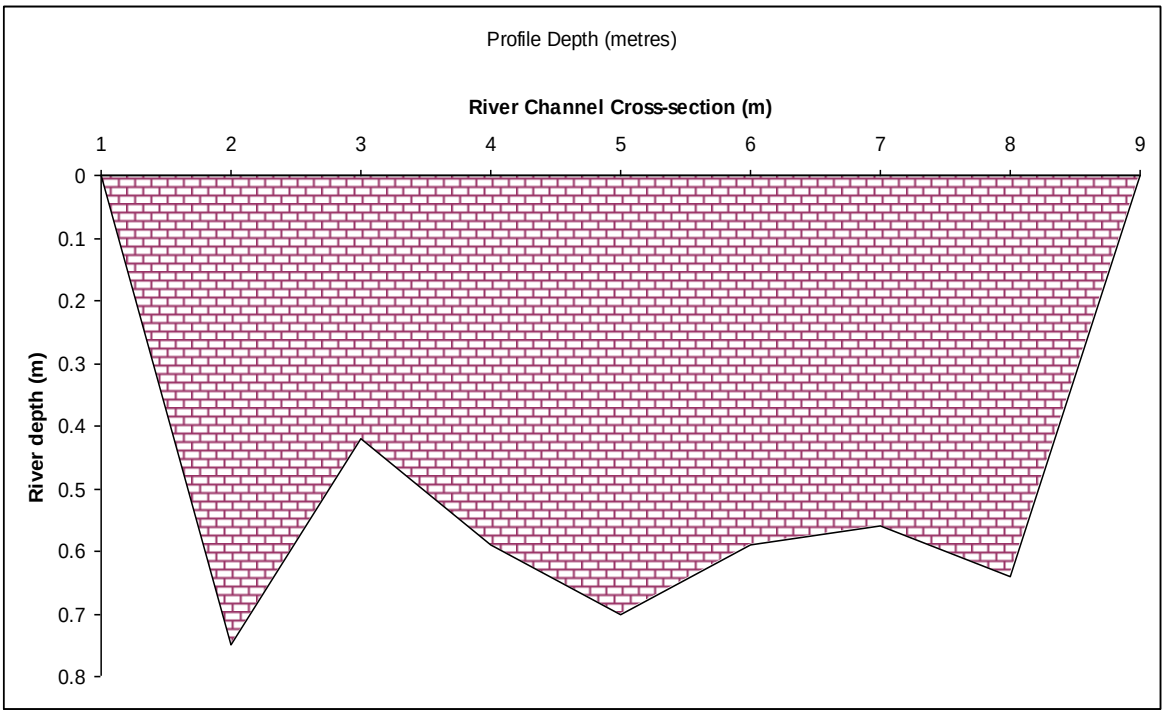


Figure 25. A Cross-sectional profile of the Tuo River profile. The Tou River during the dry season has an average depth of 1.0 meter. During the wet season, it can rise up to about 4 m depth.

# 10 Potential Environmental Risks

## 10.1 Reduced Water level at the Water Source

The water level at the water source may drop during prolonged dry periods is occurring during the drilling phase. Changes in weather patterns make it difficult to predict the probability of this situation occurring..

## 10.2 Contamination of Water Source

The water source may also be contaminated from surface water runoff from the Rig Site and the residents living near the water source. Runoff from the rig site enters the Tou River above the water source and the residents frequently use the waters upstream of the water source.

## 10.3 High Suspended Solids in Water Ways

Water quality in the water ways will be affected by construction spoils, surface runoffs and high concentration of drilling fluids when these enter the systems. This will increase turbidity and sedimentation, and also discolored the Tou River.

There is a potential for the quality of the water to be degraded and this will have a significant impact domestic use of water for the local communities at Gasuke village.

There is a potential for introduction of water borne diseases from increases in faecal coliform (pathogenic organisms) in the water system.

## 10.4 Flooding of Vegetation

Due to the fact that the soil substrate is unable to drain the surface runoff from the Rig Site, pools of water may appear in low depressions to the west of the rig site and this will form anaerobic conditions not suitable for the plants.

## 10.5 Littering of the Environment and Water Ways

Drilling operations can produce tones of garbage within short period of time and this waste is often poorly managed. The project site is very close to the river systems and waste produced on site may end up in the waterways. Therefore the HSE group will need to ensure that waste management procedures are enforced and adhered to by all employees.

## 10.6 Hazardous Materials and Hydrocarbon Spills

Drilling chemicals are often damaged in transit to locations or during handling on site. Spills often occur outside bund areas, thus releasing chemicals into the environment.

Particular attention need to be made on handling of hazardous chemicals especially at night time and on rainy days.

# 11 Environmental Aspects and Impacts

**Table 2. Environmental Aspects And Impacts Register For Ubuntu 1 Exploration Drilling Project**

Asset: _Ubuntu 1_____Completed by: SolvFit Team_____Date: 21/06/10___ Rev: _____

| Aspects | Potential Impacts (Summary of Key Contaminants ) | Existing Controls (Design, Engineering, Procedural) | RAM Ratings | Action Required/By Who/By When |
|---|---|---|---|---|
| **Air Emissions (Point Sources and Fugitive)** | | | | |
| **-Generator Exhaust**<br>**-Chemical fumes**<br>**-Dust** | 1. Generation and emission of nitrogenous oxides resulting in formation of ground level ozone and acid rain.<br>2. Generation and emission of $CO_2$ and CO gases which contributes green house gases.<br>3. Potential for respiratory illness and complications for residents | 1. Vegetation within vicinity of rig site will sequestrate green house gases.<br>2. Same as above<br>3. Apply existing health & safety procedures. | 1. Low<br>2. Low<br>3. Low | 1. Service generators to perform better and reduce thus reducing emissions<br>2. Control gases produce from diesel generators by regular servicing of generators.<br>3. Use of appropriate PPE |
| **Waste Water Discharge (Point Sources and Fugitive)** | | | | |
| **Sewage Effluents** | 1. Contamination of surface water by pathogens | 1. None<br>2. None – Need to identify and | 1. Low<br>2. Low | 1. Treat effluents in septic tanks and effluents discharged via sand pits. Identify point source, monitor & regulate. |

| Aspects | Potential Impacts (Summary of Key Contaminants ) | Existing Controls (Design, Engineering, Procedural) | RAM Ratings | Action Required/By Who/By When |
|---|---|---|---|---|
| | 2. Degradation of water quality. | monitor potential sources and entry points to surface water, | | 2. Develop and put in place a Sewage Waste Management plan and monitor. Include parameters required by DEC and the Site Specific HSE Plan for drilling, camp and water source sites. |
| **Solid Wastes** | | | | |
| **General rubbish** | 1. Littering of water ways<br>2. Littering in non approved waste disposal sites | 1. None – Segregate Waste into combustible and non-combustible.<br>2. None - Manage waste in approved sites only | 1. Medium<br>2. Medium | 1. Awareness on waste management and disposal on site<br>2. Provide containers for different types of wastes, Dispose all waste in pits, burn all combustible wastes and backfill pits with soil,<br>3. Develop Waste Management Procedure for site and enforce. |
| **Raw Materials/Products** | | | | |
| **Vegetation Clearance** | 1. Destruction of vegetation and ground cover<br>2. Habitat degradation due to sawn timber extraction<br>3. Soil erosion due to expose soil and | 1. None – Clear vegetation in required estates only<br>2. None - Manage harvesting of time for rig boards according Forestry requirements (50 cm dbh and above only)<br>3. None – stabilized construction spoils by encouraging | 1. Medium<br>2. Medium<br>3. Medium | 1. Clearly defined and mark out areas for clearance.<br>2. Undertake inventory of standing trees to be cut, do vine tending, indicate direction of fell and use lighter machine to haul timber to central location for processing.<br>3. Encourage natural regeneration in |

| Aspects | Potential Impacts (Summary of Key Contaminants ) | Existing Controls (Design, Engineering, Procedural) | RAM Ratings | Action Required/By Who/By When |
|---|---|---|---|---|
| | unstable construction spoils<br>4. Invasive Plant Species. | regeneration<br>4. None – Identify and remove non local invasive species | 4. Low | degraded areas<br>4. Remove any invasive species appearing in project area. |
| **Noise** | | | | |
| **- generators**<br>**- heavy equipment**<br>**- Chopper**<br>**-earthmoving equipment** | 1. Migration of fauna due to high level noise.<br>2. Damage to hearing. of employees<br>3. Increased noise levels due to aircraft including helicopter operations and other heavy equipment. | 1. The forests will cushioned impact of the noise on the fauna<br>2. Provision of PPE to all employees.<br>3. None – Monitor noise level on site and make employees aware of theses areas on the Rig Site | 1. Low<br>2. Medium<br>3. Low | 1. None, displaced fauna will return when site is rehabilitated<br>2. Employees must wear PPE at times when on the site<br>3. Monitor noise level and do awareness to employees |
| **Flora** | | | | |
| **-endemic**<br>**-rare**<br>**-protected**<br>**-beneficial**<br>**-medicinal** | 1. Destruction of endemic, rare and protected plant species<br>2. Loss of other forest resources (e.g. food source, hunting, shelter, building, cultural, and medicinal plants). | 1. Large undisturbed forest area.<br>2. Large undisturbed forest area.<br>3. No control mechanism for invasive species except mechanical removal on sightings | 1. Low<br>2. Low<br>3. Low | 1. Awareness to project personnel. Restrict harvesting of forest to designated areas only.<br>2. Awareness for the protection of threatened species, distribution range of protected species and management of the species<br>3. Awareness invasive plant species and control measures |

| Aspects | Potential Impacts (Summary of Key Contaminants ) | Existing Controls (Design, Engineering, Procedural) | RAM Ratings | Action Required/By Who/By When |
|---|---|---|---|---|
| | 3. Introduction of Invasive species. | | | |
| **Fauna** | | | | |
| **-endemic**<br>**-rare**<br>**-protected**<br>**-beneficial**<br>**-viability** | 1. Fragmentation of Habitats<br>2. Edge effects or exposure to extreme ambient temperature<br>3. Loss of endemic, rare and threatened species.<br>4. Displacement/migration of resident fauna.<br>5. Poaching of endemic and protected species. | 1. Large undisturbed forest area with closed Canopy cover<br>2. .Same as above<br>3. Need for awareness on protected fauna species<br>4. Large undisturbed forest area with closed Canopy cover<br>.<br>5. No market for sale of animals. | 1. Low<br>2. Low<br>3. Low<br>4. Low<br>5. Low | 1. Minimize and manage all vegetation clearing on site, provide awareness on protected endemic and endangered species and laws governing poaching of protected species. |
| **Liquid Waste** | | | | |
| Sewage<br>Kitchen discharge | 1. Impact on terrestrial environment<br>2. Impact on aquatic environment | 1. Managed by disposing it through the pits<br>2. None – Development sewage waste management procedure and monitor water quality | 1. Low<br>2. Low | 1. All sewage wastes need to be treated and managed through pipes and use of septic tanks or sand infiltration pits (trench),<br>2. .Same as point 1 above. |
| **Cultural Values** | | | | |

| Aspects | Potential Impacts (Summary of Key Contaminants ) | Existing Controls (Design, Engineering, Procedural) | RAM Ratings | Action Required/By Who/By When |
|---|---|---|---|---|
| **Camp site**<br>**Water Source**<br>**Logistical** | 1. Introduction of modern values and lifestyles<br>2. Loss of traditional cultural values and beliefs.<br>3. Law and Order Problems<br>4. Migration/settlement by outsiders<br>5. Impact on hunting and gardening sites<br>6. Loss of Land | 1. None<br>2. None<br>3. None<br>4. Village Court System<br>5. There are existing local landowners<br>6. None | 1. Low<br>2. Low<br>3. Low<br>4. Low<br>5. Low<br>6. Low | 1. None<br>2. None<br>3. None<br>4. Police to be based on site during drilling<br>5. Deal with by the local system<br>**6.** Activities to remain within lease area.. |
| **Water Resources** | | | | |
| **-Drinking**<br>**-viability (both)** | 1. Contamination of Drinking water<br>2. Sustainability of water source for drinking, drilling, camp use and maintenance of riparian ecosystem<br>3. Reduction of water flow due to prolonged dry season | 1. Install water treatment for portable water<br>2. Manage and monitor water abstraction and usage as required under the WUP | 1. Low<br>2. Low | 1. Storage of all chemicals and hydrocarbons in bunds and inspect regularly<br>2. same as above<br>3. Establish baseline water source and manage abstraction as required under the permit |
| **Dangerous Goods (including Hydrocarbons)** | | | | |
| **-DG Management**<br>**-** | 1. Chemical spill in transit and on site<br>2. Contamination of | 1. None – Follow MSDS provided for each chemical and control procedures for transport, storage | 1. Medium | 1. Develop or use existing procedures to manage DG on site<br>2. Always have HSE personnel |

| Aspects | Potential Impacts (Summary of Key Contaminants ) | Existing Controls (Design, Engineering, Procedural) | RAM Ratings | Action Required/By Who/By When |
|---|---|---|---|---|
| **Storage/Handling**<br>**-Junk/Spoil** | drinking water from hydrocarbon fuel spills and accidental releases.<br>3. Ingestion and inhalation of vapors by operators. | and handling<br>2. None – Follow MSDS provided with chemicals. For hydrocarbon spill, use oil spill management kits<br>3. Follow MSDS provided with chemicals and seek medical treatment | 2. Medium<br>3. Low | available on site at all times to manage and monitor such incidents |
| **Drill Mud and Fluids** | | | | |
| **- Drill Mud**<br>**- Drilling fluids** | 1. Contamination of surface water<br>2. Degradation of water quality<br>3. Adverse impacts on aquatic biota.<br>4. Impacts on vegetation | 1. Design and engineering control measures to be put in place.<br>2. Manage and monitor disposal of fluid entering water ways<br>3. Periodically assess streams and rivers<br>4. Alternate direction of fluid and mud disposal | 1. Medium<br>2. Medium<br>3. Low<br>4. Low | 1. Management of drilling mud/fluids by settlement pits, dilution and filtration through filter system before discharge.<br>2. Monitor water ways weekly, upstream of actively used water source and down stream.<br>3. Survey aquatic flora and fauna during drilling<br>4. Monitor impact on surrounding forests |
| **Construction Spoils/Top Soil/ Excavations Debris** | | | | |
| **- Spoils/fugitive sediments** | 1. Degradation of forest habitat.<br>2. Sedimentation/Silting<br>3. Water quality degradation | 1. Stable natural environment<br>2. Stabilized construction spoils and prevent from erosion<br>3. Direct surface runoff away from direct entry into the Tou River | 1. Low<br>2. Medium<br>3. Medium | 1. Minimize clearing of vegetations and rehabilitate exposed soil surfaces.<br>2. Direct surface water runoff from Rig Site to the northern side<br>3. Monitor water quality by sampling weekly during the drilling period. |

# 12 Proposed Management Strategies

The following strategies are proposed to minimize impacts on the local environment as well as water ways further down stream. These strategies are provided for consideration by the company, but the details will need to be scoped out prior to implementation on site.

## *12.1 Forest Regeneration*

The natural capacity of top soil as a seed source in vegetation regeneration was evident in the plant regeneration analysis. It points out the necessity to retain sufficient top soil on site to backfill the side and top cuts of drill pad when required for the purpose of rapid rehabilitation and stabilization of disturbed landscapes.

It is recommended that the top soil from future constructions be retained and use as backfill materials as they contain seeds which will germinate and colonize degraded sites

## *12.2 . Surface Water Runoff on the Rig Site*

Surface water runoff draining to the south from the Rig Site enters direct into the Tou River.

It is recommended that all surface water runoff from the Rig Site be directed to the north where it can filter through the vegetation cover before entering the nearest stream.

The existing drain will need to be directed back to the north and where there is no drain, and a proper berm 10-15 cm in height constructed along the perimeter on the east, south and western sides.

## *12.3 Drilling Foam*

Drilling foam always gives a perception of environmental contamination and therefore needs to be managed on site. The returned foam needs to break down before it enters the nearest stream.

It is recommended that the returning foam be discharged to the north to allow the foam to break and be filtered by the vegetation below.

## *12.4 Drilling Fluids and Mud Cuttings*

Contamination of water ways and degradation of the quality of water is considered as medium risks and therefore requires a management plan to effectively deal with these risks on site.

It is recommended that a pit be constructed to store the drilling fluids prior to releasing into the environment on the northern side of the Rig Site. The fluid will need to be further diluted with additional water it the retention time is short.

Drilling HSE personnel will need to monitor the impact of the drilling fluid on the vegetation and water ways and manage the release of the fluid from the mud settlement pit.

## *12.5 Surface Water Quality Monitoring*

To ensure that the company is in compliance with the required levels of parameters in the permit condition in regard to discharge of grey water and drilling fluids and cuttings, the company will undertake a sampling and monitoring program for all tributaries within the catchment of the drill site. The sampling points have been selected and are shown in Table 3 below. Water samples from these locations will provide the levels of the selected parameters' discharge from the immediate areas.

It is recommended that sampling be done weekly during the construction and drilling periods but with staff prepared to intensify the monitoring and sampling efforts during the drilling period.

**Table 3. List of sampling points and descriptions of locations.**

| **Sample Point Number** | **Location** |
|---|---|
| | |
| Sample Point No. 1 | Upstream of Tou River – 20 m from junction of Creek #1 |
| Sample Point No. 2 | Creek 1 – 10 m upstream |
| Sample Point No. 3 | Above Water source – 10 meters down from junction of Tou |
| Sample Point No. 4 | Water Source |
| Sample Point No. 5 | Tou River – 10 m above junction of dry Creek #2 |
| Sample Point No. 6 | Dry Creek 2 |
| Sample Point No. 7 | Meme creek – 10 m up stream from junction with Tou River |
| Sample Point No. 8 | Tou River – 29 m below junction of Meme Creek |
| Sample Point No. 9 | Elevala - Up stream past Damalo Village |
| Sample Point No. 10 | Tou River – 20 m up stream before junction with Elevala River. |
| Sample Point No. 11 | Elevala River – 20 m below junction with Tou River |

Samples are to be collected in 1 liter bottles (sterilized), packed with ice packs, stored in an well-insulated container, and transported to the lab for immediate analysis.

## *12.6 Solid Waste Management*

Solid wastes include all combustible and non-combustible refuse from the camps, mess, kitchen and workshops. At each location, two bins are to be provided, one for combustible and one for non-combustible materials. All waste produced must be separated into the two categories above and disposed off in the appropriate pit regularly.

HSE personnel will ensure that waste produced are properly managed at all locations.

## *12.7 Waste Oil, Fuel and other Lubricants*

All hydrocarbons brought on-site must be stored in bunded areas. The bunds must have sumps to capture leakages and spilled oil, fuel and other lubricants. The surface of the sumps must be skimmed regularly with oil absorption pads.

HSE personnel will be available on site at all times to manage and ensure that waste oil products are disposed off in approved locations only.

## *12.8 Junk Chemicals*

All chemicals identified as Junk Chemicals must be recorded into a Junk Chemical Log Sheet and stored in a separate Chemical shed or stacked on raised surface in a bund and covered with a Tarpaulin.

These chemicals must be removed from the site at the end of the project, or managed on-site by a qualified person.

Safety instructions and MSDS pertaining to each chemical must be placed in an easily accessible location and must be adhered to at all times when handling such chemicals.

## *12.9 Human Waste*

Proper toilet facilities with running water must be installed in all camps sites. HSE officers must ensure that the hygiene and health standards within the camps are practiced and such facilities are used properly.

## *12.10 Domestic and Kitchen Wastes*

All domestic wastes from the camp and the kitchen must be packed into disposable garbage bags and stored in durable storage containers to prevent scavenging. The garbage must then be disposed off regularly by burning in a burn pit.

All metal frames must be taken to and disposed off in a pit that will be dedicated for scrap metals only.

# 13 Acknowledgement

The team would like to thank Mr. Bill Momen and his field assistants for their undivided assistance in the field, the camp Manager of CPS Hagana Camp for their hospitality, the people from Damalo and Pipila on for their support for our work. Finally, thank you to the Country Manager/Lawyer of Eaglewood Energy Inc. for his support.

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# 15 Appendices

## *Appendix 1. Checklist of the plants from Project Site*

### Checklist of the plants from Ubuntu Exploration Drilling Site, Nomad district Western Province

| No. | Family | Species | No. | Family | Species |
|---|---|---|---|---|---|
| 1.0 | Acanthaceae | *Strobilanthes sp* | 101.0 | Meliaceae | *Aglaia subminutiflora* |
| 2.0 | Amaranthaceae | *Cyathula sp* | 102.0 | Meliaceae | *Chisocheton ceramicus Miq.* |
| 3.0 | Anacardiaceae | *Dracontamelon dao* | 103.0 | Meliaceae | *Dysoxylum mullerii* |
| 4.0 | Anacardiaceae | *Semecarpus indica* | 104.0 | Meliaceae | *Dysoxylum sp* |
| 5.0 | Anacardiaceae | *Semecarpus sp1* | 105.0 | Meliaceae | *Dysoxylum sp1* |
| 6.0 | Anacardiaceae | *Semecarpus sp2* | 106.0 | Mernispermaceae | *Tinomiscium sp* |
| 7.0 | Annonaceae | *Cananga odorata* | 107.0 | Mernispermaceae | *Tinospora sp* |
| 8.0 | Annonaceae | *Cyathocalyx cf.polycarpum White&Francis* | 108.0 | Monimiaceae | *Kibara sp* |
| 9.0 | Annonaceae | *Oncodostigma sp* | 109.0 | Moraceae | *Artocarpus vriesianus* |
| 10.0 | Annonaceae | *Papualthia sp* | 110.0 | Moraceae | *Ficus sp* |
| 11.0 | Annonaceae | *Papualthia sp2* | 111.0 | Myristicaceae | *Horsfieldia sp* |
| 12.0 | Annonaceae | *Polyalthia oblongifolium* | 112.0 | Myristicaceae | *Myristica sabualulata* |
| 13.0 | Annonaceae | *Polyalthia sp1* | 113.0 | Myristicaceae | *Myristica sepincana* |
| 14.0 | Annonaceae | *Popowia sp* | 114.0 | Myristicaceae | *Myristica sp* |
| 15.0 | Annonaceae | *Popowia sp1* | 115.0 | Myristicaceae | *Myristica sp1* |
| 16.0 | Annonaceae | *Rauwenhoffia sp* | 116.0 | Myristicaceae | *Myristica wormersleyii* |
| 17.0 | Apocynaceae | *Alyxia sp* | 117.0 | Myrsinaceae | *Ardisia sp* |
| 18.0 | Araceae | *Alocasia alocacia* | 118.0 | Myrsinaceae | *Myrsinia sp* |
| 19.0 | Araceae | *Epipremnum sp* | 119.0 | Myrsinaceae | *Rapanea sp* |
| 20.0 | Araceae | *Homalomena lauterbachii Engl.* | 120.0 | Myrtaceae | *Acmena sp* |
| 21.0 | Araceae | *Pothos albertisii Engl.* | 121.0 | Myrtaceae | *Rhodomyrtus sp* |
| 22.0 | Araceae | *Rhaphidophora geniculata Engl.* | 122.0 | Myrtaceae | *Syzygium malaciensis* |
| 23.0 | Araucariaceae | *Agathis labillardia* | 123.0 | Myrtaceae | *Syzygium sp* |
| 24.0 | Arecaceae | *Arenga sp* | 124.0 | Myrtaceae | *Syzygium sp1* |
| 25.0 | Arecaceae | *Calamus hollrungii* | 125.0 | Myrtaceae | *Syzygium leonhardi* |
| 26.0 | Arecaceae | *Caryota rumphii* | 126.0 | Myrtaceae | *Xanthomyrtus sp* |

| | | | | | |
|---|---|---|---|---|---|
| 27.0 | Arecaceae | *Gronophyllum sp* | 127.0 | Oleaceae | *Chionanthus sp* |
| 28.0 | Arecaceae | *Gulubia costata* | 128.0 | Orchidaceae | *Bulbophyllum sp* |
| 29.0 | Arecaceae | *Heterospathe humilis* | 129.0 | Orchidaceae | *Corymborkis sp* |
| 30.0 | Arecaceae | *Licuala sp* | 130.0 | Orchidaceae | *Dendrobium sp* |
| 31.0 | Arecaceae | *Orania sp* | 131.0 | Orchidaceae | *Phaius sp* |
| 32.0 | Arecaceae | *Ptychococcus* | 132.0 | Palmaceae | *Heterospathe sp* |
| 33.0 | Aristolochiaceae | *Aristolochia momandul* | 133.0 | Pandanaceae | *Freycinetia novohibernica* |
| 34.0 | Aspleniaceae | *Asplenium sp* | 134.0 | Pandanaceae | *Pandanus sp* |
| 35.0 | Aspleniaceae | *Hoya sp* | 135.0 | Piperaceae | *Piper betel* |
| 36.0 | Barringtoniaceae | *Barringtonia acalypha* | 136.0 | Pittosporaceae | *Pittosporum sinnuatum* |
| 37.0 | Barringtoniaceae | *Barringtonia josephstalenii* | 137.0 | Poaceae | *Mapania sp* |
| 38.0 | Barringtoniaceae | *Barringtonia sp* | 138.0 | Polypodiaceae | *Polypodium sp* |
| 39.0 | Barringtoniaceae | *Barringtonia sp1* | 139.0 | Polypodiaceae | *Pyrrosia sp1* |
| 40.0 | Barringtoniaceae | *Planchonia papuana* | 140.0 | Proteaceae | *Finschia rufra* |
| 41.0 | Burseraceae | *Canarium macdamii* | 141.0 | Proteaceae | *Finschia sp1* |
| 42.0 | Burseraceae | *Canarium sp* | 142.0 | Proteaceae | *Helicia sp* |
| 43.0 | Celastraceae | *Celastrus sp* | 143.0 | Rhamnaceae | *Zizyphus sp* |
| 44.0 | Clusiaceae | *Garcinia sp* | 144.0 | Rosaceae | *Prunus gazelle-peninsula* |
| 45.0 | Clusiaceae | *Garcinia sp1* | 145.0 | Rosaceae | *Rubus sp* |
| 46.0 | Clusiaceae | *Garcinia sp2* | 146.0 | Rubiaceae | *Anthocephalus chinensis* |
| 47.0 | Combretaceae | *Terminalia solomonensis* | 147.0 | Rubiaceae | *Gardenia papuana* |
| 48.0 | Combretaceae | *Terminalia sp* | 148.0 | Rubiaceae | *Ixora sp* |
| 49.0 | Commelinaceae | *Commelina sp* | 149.0 | Rubiaceae | *Ixora sp* |
| 50.0 | Cucurbitaceae | *Mukia sp* | 150.0 | Rubiaceae | *Mastixiodendron sp* |
| 51.0 | Cycadaceae | *Cycas circinalis* | 151.0 | Rubiaceae | *Mussaenda ferruginea* |
| 52.0 | Davalliaceae | *Davallia sp* | 152.0 | Rubiaceae | *Neonauclea sp1* |
| 53.0 | Dilleniaceae | *Tetracera sp* | 153.0 | Rubiaceae | *Psychotria sp* |
| 54.0 | Dipteridaceae | *Dipteris sp* | 154.0 | Rubiaceae | *Psychotria sp1* |
| 55.0 | Dipterocarpaceae | *Vatica sp* | 155.0 | Rubiaceae | *Psychotria sp2* |
| 56.0 | Ebenaceae | *Diospyros maritima* | 156.0 | Rubiaceae | *Randia sp* |
| 57.0 | Ebenaceae | *Diospyros sp1* | 157.0 | Rubiaceae | *Timonius belensis* |
| 58.0 | Ebenaceae | *Diospyros sp2* | 158.0 | Rubiaceae | *Timonius timon* |
| 59.0 | Ebenaceae | *Diospyros sp2* | 159.0 | Rubiaceae | *Uncaria sp* |
| 60.0 | Elaeocarpaceae | *Elaeocarpus sp* | 160.0 | Rubiaceae | *Uvaria sp* |
| 61.0 | Elaeocarpaceae | *Elaeocarpus sphaericus* | 161.0 | Rubiaceae | *Versteegia sp* |
| 62.0 | Elaeocarpaceae | *Sloanea naumanii* | 162.0 | Rutaceae | *Evodia sp* |
| 63.0 | Elaeocarpaceae | *Sloanea* | 163.0 | Rutaceae | *Geijera sp* |

| | | | | | |
|---|---|---|---|---|---|
| | | *sogeriensis* | | | |
| 64.0 | Elaeocarpaceae | *Sloanea sogeriensis* | 164.0 | Sapindaceae | *Alectryon dentatus* |
| 65.0 | Elaeocarpaceae | *Sloanea sogeriensis* | 165.0 | Sapindaceae | *Ganophyllum falcateria* |
| 66.0 | Elaeocarpaceae | *Sloanea sp2* | 166.0 | Sapindaceae | *Guioa oligotricha* |
| 67.0 | Euphorbiaceae | *Aporusa sp* | 167.0 | Sapindaceae | *Guioa sp* |
| 68.0 | Euphorbiaceae | *Croton sp* | 168.0 | Sapindaceae | *Harpullia cupaniodes* |
| 69.0 | Euphorbiaceae | *Endiandra sp* | 169.0 | Sapindaceae | *Harpullia sp* |
| 70.0 | Euphorbiaceae | *Ficus Macrura* | 170.0 | Sapindaceae | *Mischocarpus pyriformis* |
| 71.0 | Euphorbiaceae | *Glochidion sp* | 171.0 | Sapindaceae | *Pometia pinnata* |
| 72.0 | Euphorbiaceae | *Macaranga sp1* | 172.0 | Sapotaceae | *Chrysophyllum roxburgii* |
| 73.0 | Euphorbiaceae | *Phyllanthus sp* | 173.0 | Sapotaceae | *Chrysophyllum roxburgii* |
| 74.0 | Euphorbiaceae | *Pimelodendron amboinicum* | 174.0 | Sapotaceae | *Palaquim warburgianum* |
| 75.0 | Fabaceae | *Derris sp* | 175.0 | Sapotaceae | *Pouteria sp* |
| 76.0 | Fabaceae | *Maniltoa psilogyne Harms* | 176.0 | Sapotaceae | *Pouteria sp1* |
| 77.0 | Flacourtiaceae | *Erythrospermum sp* | 177.0 | Sapotaceae | *Pouteria sp2* |
| 78.0 | Flacourtiaceae | *Homalium foetidum* | 178.0 | Selaginellaceae | *Selaginella sp* |
| 79.0 | Flagellariaceae | *Flagellaria indica* | 179.0 | Shizaeaceae | *Lygodium sp* |
| 80.0 | Gesneriaceae | *Cyrtandra sp* | 180.0 | Smilicaceae | *Smilax sp* |
| 81.0 | Gnetaceae | *Gnetum costatum* | 181.0 | Smilicaceae | *Smilax calophylla* |
| 82.0 | Gnetaceae | *Gnetum gnemon* | 182.0 | Sterculiaceae | *Firmiana papuana* |
| 83.0 | Gnetaceae | *Gnetum latifolium* | 183.0 | Symploccaceae | *Symploccos cochicinensis* |
| 84.0 | Grossulariaceae | *Polyosma sp* | 184.0 | Symploccaceae | *Symploccos sp* |
| 85.0 | Icacinaceae | *Gomphandra sp* | 185.0 | Thelypteridaceae | *Sphaerostephanos sp* |
| 86.0 | Icacinaceae | *Platea sp* | 186.0 | Ulmaceae | *Celtis sp* |
| 87.0 | Icacinaceae | *Rhyticaryum sp* | 187.0 | Verbenaceae | *Teijsmanniodendron sp* |
| 88.0 | Icacinaceae | *Stemonurus sp* | 188.0 | Vitaceae | *Petraeovitex sp* |
| 89.0 | Lauraceae | *Cryptocarya sp* | 189.0 | Vitaceae | *Pseuduvaria sp* |
| 90.0 | Lauraceae | *Endiandra sp* | 190.0 | Xanthophyllaceae | *Xanthophyllum warburgianum* |
| 91.0 | Lauraceae | *Litsea guphii* | 191.0 | Zingiberaceae | *Alpinia sp* |
| 92.0 | Lauraceae | *Litsea sp* | 192.0 | Zingiberaceae | *Alpinia sp1* |
| 93.0 | Leeaceae | *Leea sp* | 193.0 | Zingiberaceae | *Amomum sp* |
| 94.0 | Liiliaceae | *Dracaenia sp* | 194.0 | Zingiberaceae | *Riedelia sp* |
| 95.0 | Magnoliaceae | *Elmerrilia papuana* | 195.0 | Zingiberaceae | *Hornstedtia sp* |
| 96.0 | Marattiaceae | *Angiopteris sp* | 196.0 | Zingiberaceae | *Costus sp* |
| 97.0 | Melastomataceae | *Medinella sp* | 197.0 | Vitaceae | *Cayratia sp* |

| | | | | | |
|---|---|---|---|---|---|
| 98.0 | Meliaceae | *Aglaia cucullata* | 198.0 | Rubiaceae | *Tarenna sp* |
| 99.0 | Meliaceae | *Aglaia sapindina* | 199.0 | Stemonaceae | *Stemona sp* |
| 100.0 | Meliaceae | *Aglaia sp1* | 200.0 | Orchidaceae | *Grastidium sp* |
| 101.0 | | | 201.0 | Orchidaceae | *Diplocaulobium sp* |

## *Appendix 2. Checklist of the Mammals Known from the Region.*

### Checklist of the Mammals of Known from the region (Juha, Upper Fly River and Nomad District) including those sighted during this study.

| FAMILY | *Species Name* | Common Name | IUCN Status | Comments |
|---|---|---|---|---|
| | | | | |
| ACROBATIDAE | *Distoechurus pennatus* | Feather-tailed Possum | Lower risk, least concern | Reported by locals |
| BURRAMYIDAE | *Cercarteus caudatus* | Long-tailed Pygmy Possum | Lower risk, least concern | Reported by locals |
| DASYURIDAE | *Dasyurus albopunctatus* | New Guinea Quoll | Vulnerable | Reported by locals |
| DASYURIDAE | *Murexia longicaudata* | Short-furred Dasyure | Lower risk, least concern | Reported by locals |
| DASYURIDAE | *Myoictis melas* | Three-striped Dasyure | endemic* rare | Reported by locals |
| MACROPODIDAE | *Dendrolagus dorianus* | Doria's Tree Kangaroo | endemic* vulnerable, rare | Reported by locals, rarely occurs in the area |
| MACROPODIDAE | *Dendrolagus spadix* | Lowland Tree Kangaroo | Endangered, rare | Reported by locals, becoming rare today |
| MACROPODIDAE | *Dorcopsis luctuosa* | Grey Dorcopsis | endemic*common | Reported specimen seen, number decreased |
| MACROPODIDAE | *Dorcopsulus vanheurni* | Small Dorcopsis | endemic*common | Reported by locals, had become rare locally |
| MURIDAE | *Leptomys elegans* | Long-footed Hydrominae | endemic*uncommon | Reported by locals |
| MURIDAE | *Leptomys ernstmayeri* | Ernst Mayer's Leptomys | endemic* | Reported by locals |
| MURIDAE | *Lorentzimys nouhuysi* | Long-footed Tree Mouse | endemic*uncommon | Reported by locals |
| MURIDAE | *Melomys leucogaster* | White-bellied Melomys | endemic*common | Reported by locals |
| MURIDAE | *Melomys lorentzii* | Lorentz's Melomys | endemic | Caught in the trap |
| MURIDAE | *Melomys rubex* | Mountain Melomys | common | Caught in the trap |
| MURIDAE | *Rattus novaeguineae* | New Guinea Rat | endemic* | Caught in the trap |
| MURIDAE | *Rattus* sp.1 | undescribed species of Rattus | unknown | Caught in the trap |

| | | | | |
|---|---|---|---|---|
| MURIDAE | *Stenomys niobe* | Moss Forest Rat | endemic*common | Caught in the trap |
| MURIDAE | *Xenuromys barbatus* | Rock-dwelling Rat | endemic*rare | Caught in the trap |
| PERORYCTIDAE | *Microperoryctes longicauda* | Stripped Bandicoot | common | Existence evidence observed in the forest |
| PETAURIDAE | *Dactylopsis trivirgata* | Stripped Possum | common | Heard calls in the night, confirmed by locals |
| PHALANGERIDAE | *Phalanger carmelitae* | Mountain Cuscus | endemic*common | Reported by locals, skin specimens kept by locals |
| PHALANGERIDAE | *Phalanger gymnotis* | Ground Cuscus | common | Reported by locals |
| PHALANGERIDAE | *Phalanger intercastellanus* | Common Cuscus | common | Reported by locals, heard calls in the night |
| PHALANGERIDAE | *Spilocuscus maculatus* | Spotted Cuscus | common | Evidence (feeding remnants) of existence observed |
| PHALANGERIDAE | *Spilocuscus maculatus goldei* | Common Spotted Cuscus | Vulnerable | Reported by locals |
| PSEUDOCHEIRIDAE | *Pseudochirops corinnae* | Plush-coated Ringtail | Vulnerable | Skin specimens kept by locals |
| PSEUDOCHEIRIDAE | *Pseudochirulus mayeri* | Pygmy Ringtail | common | Reported by locals |

## *Appendix 3. The GPS Way Points Indicating References to the Sample Sites*

**The GPS data taken at the Way Points indicating references to the sample sites, topographical features and villages along the route taken by the team. These GPS references are marked on the tracking chart in Figure 2**

| Station Type Symbol Description | Bearings | Latitude | Longitude | Elevation | Distance to (Next Stn) |
|---|---|---|---|---|---|
| | | | | | |
| Bird Sample site | 306.28° | S06 06 35.0 | E141 54 41.8 | 67.50 m | 1439.85 m |
| Cellar 2 | 75.91° | S06 07 02.4 | E141 55 20.9 | 107.30 m | 42.12 m |
| Cellar 1 | 75.39° | S06 07 02.4 | E141 55 20.7 | 107.10 m | 36.23 m |
| Transect 2 | 109.34° | S06 07 03.6 | E141 55 22.2 | 106.40 m | 84.88 m |
| Transect 1 | 124.08° | S06 07 03.7 | E141 55 21.0 | 104.90 m | 54.70 m |
| Soil P Beach | 274.08° | S06 05 19.5 | E141 31 21.8 | 29.93 m | 44.32 km |
| River Gravel Beach | 274.90° | S06 04 50.8 | E141 29 51.0 | 28.96 m | 47.17 km |
| Old sawmill Ste | 302.82° | S06 06 41.3 | E141 54 46.3 | 72.22 m | 1215.12 m |
| Hagana Camp | 311.02° | S06 06 30.1 | E141 54 42.0 | 93.90 m | 1528.86 m |
| Surveyors Peg | 213.70° | S06 07 06.4 | E141 55 17.1 | 67.70 m | 136.04 m |
| Soil Profile | 305.04° | S06 06 51.1 | E141 55 02.9 | 77.80 m | 624.53 m |
| Minge – Elevala Junction | 272.76° | S06 06 40.6 | E141 47 41.8 | 47.70 m | 14.09 km |
| Gasuke 2 Beach | 274.41° | S06 06 12.6 | E141 44 31.4 | 45.80 m | 19.99 km |
| Gasuke 1 Beach | 274.19° | S06 06 13.4 | E141 44 08.9 | 46.30 m | 20.68 km |
| Wara Tou Flag, Blue Flag, Blue | 270.14° | S06 07 02.3 | E141 52 39.0 | 58.30 m | 4.94 km |
| Ridge top Flag, Blue Flag, Blue | 315.97° | S06 05 43.7 | E141 54 03.2 | 105.15 m | 3.38 km |
| Ridge Top 2 Flag, Blue Flag, Blue | 313.24° | S06 05 56.6 | E141 54 09.3 | 111.16 m | 2.96 km |
| Damalo Village Flag, Blue Flag, Blue | 311.36° | S06 05 41.1 | E141 53 46.9 | 63.81 m | 3.80 km |
| Damalo Point Flag, Blue Flag, Blue | 318.13° | S06 05 34.3 | E141 54 00.4 | 65.01 m | 3.65 km |
| 025 Flag, Blue Flag, Blue | 318.10° | S06 05 34.7 | E141 54 00.7 | 66.22 m | 3.63 km |

| | | | | | |
|---|---|---|---|---|---|
| River Junction Flag, Blue Flag, Blue | 275.00° | S06 04 43.9 | E141 29 02.5 | 30.40 m | 48.68 km |
| Tisore Village Flag, Blue Flag, Blue | 275.03° | S06 04 41.7 | E141 28 47.6 | 30.40 m | 49.14 km |
| Tisore Village Flag, Blue Flag, Blue | 274.79° | S06 04 46.4 | E141 28 22.9 | 29.90 m | 49.88 km |
| 018 Flag, Blue Flag, Blue | 273.18° | S06 05 30.4 | E141 27 53.4 | 31.13 m | 50.70 km |
| 017 Flag, Blue Flag, Blue | 273.11° | S06 05 33.2 | E141 28 04.6 | 30.89 m | 50.35 km |
| 016 Flag, Blue Flag, Blue | 273.86° | S06 05 08.9 | E141 27 23.5 | 30.89 m | 51.65 km |
| 015 Flag, Blue Flag, Blue | 274.91° | S06 04 26.2 | E141 25 07.8 | 31.61 m | 55.92 km |
| 014 Flag, Blue Flag, Blue | 274.80° | S06 04 29.0 | E141 24 58.6 | 30.41 m | 56.19 km |
| 013 Flag, Blue Flag, Blue | 274.79° | S06 04 29.0 | E141 24 58.5 | 30.17 m | 56.19 km |
| 012 Flag, Blue Flag, Blue | 272.33° | S06 05 45.5 | E141 24 07.6 | 31.37 m | 57.61 km |
| 011 Flag, Blue Flag, Blue | 272.32° | S06 05 45.8 | E141 24 07.2 | 31.85 m | 57.62 km |
| 010 Flag, Blue Flag, Blue | 272.32° | S06 05 45.9 | E141 24 06.9 | 31.13 m | 57.63 km |
| 008 Flag, Blue Flag, Blue | 98.98° | S06 51 20.7 | E146 44 29.9 | 1814.60 m | 539.31 km |
| 007 Flag, Blue Flag, Blue | 84.62° | S05 48 37.4 | E145 04 41.3 | 2994.13 m | 351.08 km |
| 006 Flag, Blue Flag, Blue | 84.66° | S05 48 45.4 | E145 04 52.3 | 2925.40 m | 351.40 km |
| 005 Flag, Blue Flag, Blue | 84.67° | S05 48 47.2 | E145 04 53.4 | 2903.05 m | 351.43 km |